The many friends of Bob Peebles will remember him always for his vivid and lovable personality. He was so very much alive that we can scarcely realize, even yet, that he is no longer with us. He has left a void that will be very hard to fill.—Thomas H. Kearney, California Academy of Sciences, San Francisco.

THE CHROMOSOMAL AND DISTRIBUTIONAL RELATIONSHIPS OF LUPINUS TEXENSIS AND L. SUBCARNOSUS (LEGUMINOSAE)

B. L. Turner

The genus *Lupinus* is represented in Texas by several species (Shinners, 1953). Of these, the two most commonly encountered are *L. texensis* Hook. and *L. subcarnosus* Hook. The latter taxon is the official state flower of Texas, though *L. texensis* is sometimes mistaken for this species. Both species are endemic to the state and are known locally as bluebonnets. They are probably the most important native rangeland legumes in central Texas, often occupying hundreds of acres of rolling hillsides during the early spring months. The roots of these species are highly nodulated and are undoubtedly important soil nitrifiers. In addition, *L. texensis* has become a popular garden ornamental in many parts of the world. (Although many trade catalogues list *L. subcarnosus* as the Texas bluebonnet, most of the material on the open market appears to be *L. texensis*.)

Geographical Distribution

Lupinus texensis occurs naturally on open calcareous soils throughout central Texas. *Lupinus subcarnosus* is restricted to sandy soils of south-central Texas. The interfingered distribution of the two species (Fig. 1) can be related to alternating grassland — forest strips which occur on deep clay and sandy soils respectively. The ecotone between these vegetative types is sharp, and consequently both species may be found growing in close proximity along many miles of the contact area. *Lupinus texensis* has a wide ecologic amplitude and may grow in a variety of disturbed soil types. As a result, the species has become established along road shoulders which cross the otherwise unoccupied sandy lands, particularly as a result of deliberate sowing by state highway workers and other wildflower enthusiasts. *Lupinus subcarnosus* is rarely if at all sown along highways, and in no instance has the author seen the plant growing naturally on clay soils or along highways in such areas. In the numerous cases where both species were found growing together during the spring of 1955, no sign of morphologic intergradation, meiotic irregularity, or other evidence of hybridization could be detected.

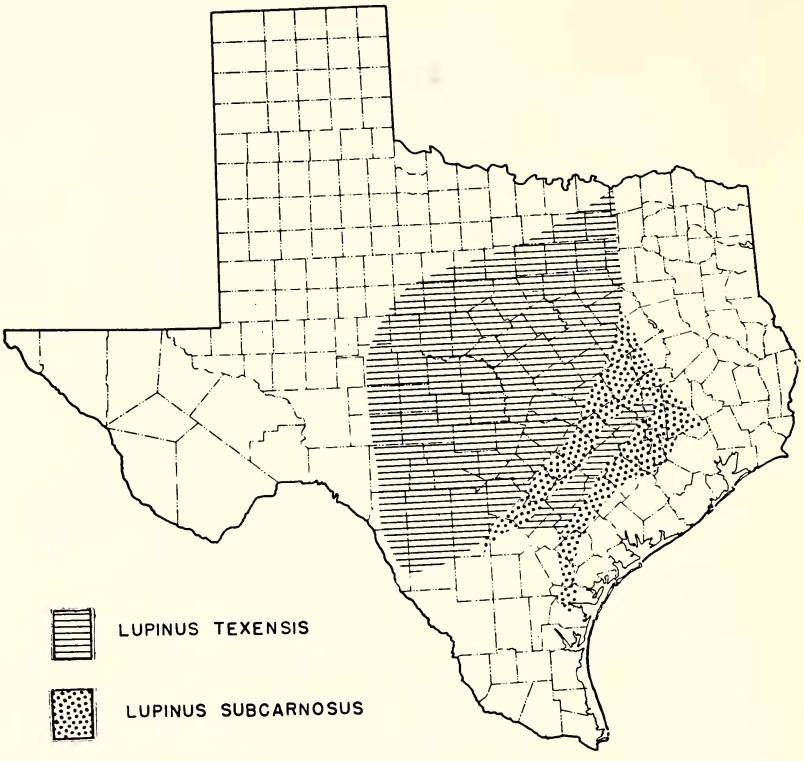


Fig. 1. Probable natural distribution of *Lupinus texensis* and *L. subcarnosus*. Based on herbarium records at The University of Texas and extensive field observation. Further explanation in text.

Chromosome Numbers

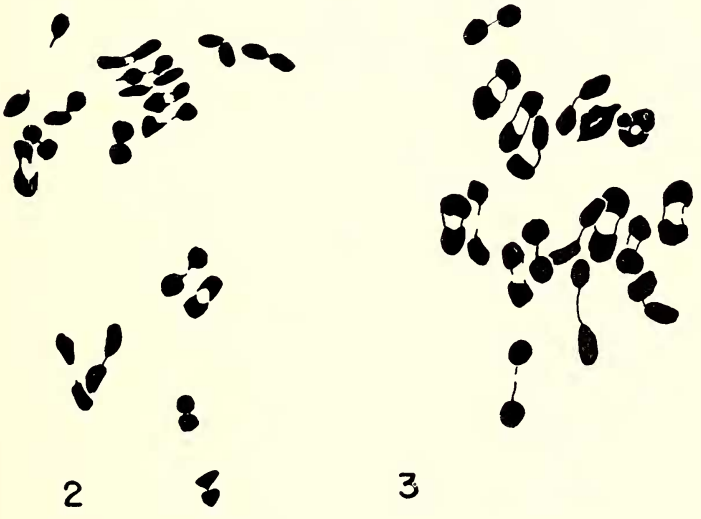
Previous to the present study, two different counts had been reported for *L. subcarnosus*. Savchenko (1935) reported 2n = 48 and Tuschnjakowa (1935) reported 2n = 36 for this species. Because of the past confusion in the application of the names *L. texensis* and *L. subcarnosus* (Shinners, 1953), it was at first thought that the two differing counts might be for *both* species instead of *L. subcarnosus* alone. As a result, meiotic studies[1] of natural populations of these two taxa were undertaken. However, it was soon discovered that both *L. texensis* and *L. subcarnosus* had the same chromosome number of n = 18. In all instances, meiosis was completely regular, metaphase plates showing 18 bivalents and anaphase plates were without bridges. Counts obtained are given in Table 1.

[1] Buds were killed and fixed in a mixture of 4 chloroform:3 absolute alcohol:1 glacial acetic acid. Anthers were squashed in acetocarmine 2 to 3 days after collection. Voucher specimens are deposited at the University of Texas Herbarium, Austin, Texas.

Table 1. Chromosome Counts of Lupinus subcarnosus and L. texensis

Species	Collection	n number
L. subcarnosus	Bastrop County: Bastrop State Park. *Turner 3703.*	18
L. subcarnosus	Bastrop County: 4 miles west of Bastrop. *Turner 3704.*	18
L. subcarnosus	Gonzales County: near Palmetto State Park entrance. *Turner 3708.*	18
L. subcarnosus	Fayette County: 2 miles west of Moulton. *Turner 3712.*	18
L. subcarnosus	Lavaca County: Sublime. *Turner 3719.*	18
L. subcarnosus	Colorado County: 5 miles west of Altair. *Turner 3723.*	18
L. subcarnosus	Fort Bend County: 0.5 mile east of Fulshear. *Turner 3727.*	18
L. subcarnosus	Austin County: San Felipe State Park. *Turner 3730.*	18
L. texensis	Travis County: Austin. *Turner 3699.*	18
L. texensis	Lavaca County: 2 miles west of Moulton. *Turner 3713.*	18
L. texensis	Lavaca County: 1 mile southeast of Shiner. *Turner 3718.*	18
L. texensis	Austin County: 3 miles east of Ulm. *Turner 3732.*	18
L. texensis	Hays County: 10 miles west of San Marcos. *Turner 3733.*	18
L. texensis	Llano County: 3 miles northwest of Buchanan Dam. *Turner and Johnston 2523.*	18

Savchenko's number of 2n = 48 was apparently for some misnamed taxon, or else strains of *L. subcarnosus* and/or *L. texensis* exist in the ornamental trade as derived polyploids. Savchenko did not cite voucher material but merely indicated that the counts were made from seeds obtained from Germany.



Figs. 2–3. Metaphase chromosomes of *Lupinus texensis* and *L. subcarnosus: 2, L. texensis,* n = 18; *3, L. subcarnosus,* n = 18. Camera lucida drawings, × 2000.

Discussion

Lupinus texensis and *L. subcarnosus* are apparently very closely related as shown by their external morphological characters and their similar chromosome complements. However, they are clearly separated ecologically and in the field they are reproductively isolated. The reproductive isolation is perhaps partially due to the self-pollinating nature of the breeding populations; naturally occurring cross-pollinated individuals are probably rare. Experimental hybridization between these two species is being undertaken.

The discovery that both *L. texensis* and *L. subcarnosus* have chromosome numbers of $n = 18$ has certain phyletic implications. Senn (1938), on the basis of Tuschnjakowa's reported number for *L. subcarnosus,* considered the species to be triploid in origin and thus, along with 2n counts of 48 in other species, concluded the base number for the genus to be $x = 12$ instead of 8, 9, 10, etc., as has been indicated by other workers (Darlington and Janaki-Ammal, 1945). Senn considered species with n numbers of 20, 21, 25, etc. to be derived aneuploids. The only other number of $n = 18$ reported for the genus *Lupinus* is that made by Eickhorn (1949) on *L. tassilicus* Maire.

Summary

The distributional relationship of *L. texensis* and *L. subcarnosus* has been indicated. The former species is widespread throughout central Texas, occurring in calcareous soils; the latter is more restricted in range, occurring on sandy soils of south-central Texas. Meiotic counts from a number of localities in central Texas showed the chromosome number of both species to be $n = 18$. An earlier report of $2n = 48$ for *L. subcarnosus* was probably erroneous. In spite of the morphological and chromosomal similarities of the two species, they do not hybridize in nature, even in habitats which permit their side-by-side occurrence.

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Literature Cited

Darlington, C. D. and E. K. Janaki-Ammal. 1945. Chromosome Atlas of Cultivated Plants. London. 397 pp.

Eickhorn, A. 1949. A propos de la caryologie du Lupinus tassilicus Maire. Rev. Cytol. et Biol. Veg. 11: 333–350.

Savchenko, P. F. 1935. Karyology of some species of the genus Lupinus. Bull. Applied Botany, of Genetics and Plant Breeding. Series II, No. 8: 105–112. (In Russian; English summary on pp. 197–198 of same journal.)

Senn, H. A. 1938. Chromosome number relationships in the Leguminosae. Bibliographie Genetica 12: 175–336.

Shinners, L. H. 1953. The bluebonnets (Lupinus) of Texas. Field and Lab. 21: 149–153.

Tuschnjakowa, M. 1935. Über die Chromosomen einiger Lupinus-Arten. Der Züchter 7: 169–174.